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Hemolytic Streptococci of the Appendix Vermiformis

HEMOLYTIC STREPTOCOCCI OF THE APPENDIX VERMIFORMIS

BY

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Adolph Kraft

ENTITLED Hemolytic Streptococci of the Appendix Vermiformis.

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF Master of Science

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INTRODUCTION

Since the discovery of the streptococcus hemolyticus, sufficient investigation has not been undertaken to determine the relation of that bacterium to the normal and pathological conditions of the appendix vermiformis. Both surgeons and internists frequently associate appendicitis with this organism. Therefore, before presenting the investigative work on the subject, it is fitting that some mention be made of the anatomy, histology and physiology of the appendix vermiformis; the history and chief characteristics of the organism in question; the occurrence of the organism elsewhere in the gastro-intestinal tract; and of the etiology of appendicitis as it has heretofore been recognized, in order that a fair relative comparison of my own results and that of others may be made.

APPENDIX VERMIFORMIS (1)

The appendix vermiformis is a tubular worm-like outgrowth of the medial and posterior part of the caecum, about 2.5 to 3.75 cm. below the ileocaecal orifice; it usually extends in one of three directions; - 1.over the brim into the pelvis; 2. upwards behind the caecum; or, 3. upwards toward the spleen. Any of the above positions are considered normal; but, it may be situated practically anywhere that its length and mesentery may allow.

It varies greatly in size; it may be absent (Fawcett) or attain a length of nine inches. The average length is given as 92 mm., and the breadth as 6 mm. (Berry).

The lumen or cavity is perhaps as variable as the size

and position. In at least one-fourth of all adults, the lumen is partially or totally closed. An insignificant valve may be at the opening into the caecum. It may be more or less sacculated.

The main blood supply is from a branch of the ileo-caecal artery which approaches the organ from behind the caecum.

The lymphatic drainage is into a group of lymph nodes, most of which are at the angle of the ileum and the caecum.

Histologically the appendix vermiformis consists of a perfect investment of serosa, a muscular layer, a submucosa and mucosa, all of which are continuous with that of the caecum. There is an ill-defined lamina muscularis between the base of the intestinal glands and the submucosa. The striking feature of its structure is the exceptionally large amount of lymphoid tissue, the mucosa being in part packed with it.

Physiologically, little or nothing is known of its function. No recognized metabolic change or disturbance is noted when it is removed.

HISTORY AND CHARACTERISTICS OF THE STREPTOCOCCI

Pathological lesions produced by the hemolytic streptococci were recognized long before that organism was discovered. In 1883, Fehleisen (2) no doubt isolated a hemolytic streptococcus from a case of erysipelas and named it the "Micrococcus of Erysipelas", (also called the "Streptococcus Erysipelatos"), but it was not then known to be hemolytic. Rosenbach (3) in 1884 and Passet (4) in 1885 reported the isolation of a similar strain from the pus of acute abscesses and called it "Streptococcus Pyogenes"; which name is still in use.

Hemolytic streptococci are Gram positive cocci, usually occurring in chains of various length; they also appear as diplococci, the form depending upon a number of factors, as media, temperature, duration of incubation, and also individual peculiarities of certain strains. They vary in size from 1 to 2 μ, and are almost round; pleomorphic strains occur occasionally. They are hemolytic, that is they produce a wide, clear zone of complete hemolysis about a small pin point colony on blood agar. The zone of hemolysis is usually 2 to 4 mm. in diameter, but this varies considerably under various conditions. Pathogenic hemolytic streptococci at times do not grow on plain agar, or on plain neutral beef broth, especially when first isolated. They grow best at a temperature 36°C to 37°.5 C or approximately the temperature of the human body. Medium commonly used for the isolation and growth of this organism is blood-agar. Hemolytic streptococci are usually aerobic and facultative anaerobic. I have isolated an anaerobic hemolytic streptococcus; it retained the strictly anaerobic property, at least for several transplantations.

Hemolytic streptococci are not bile soluble; furthermore, the strains usually met with do not ferment inulin.

When injected intravenously into experimental animals, these organisms, unless previously attenuated, usually produce a septicemia; and also often arthritis, endocarditis and lesions in other tissues such as the walls of the stomach, appendix and gall-bladder. Rosenow (5) has placed considerable stress upon the specific selective action of certain strains. Rosenow, Towne and Von Hess (6) conclude that streptococci found so

constantly in poliomyelitis tend to localize electively in the nervous system in young guinea pigs, rabbits, puppies and kittens. Brown (7) mentions the reproduction of cholecystitis by isolated strains from pathological gall-bladders. However, others have failed to confirm their work, and Broadhurst (8) says that the streptococcal infections are those of opportunity rather than of specificity. If certain strains do have a selective affinity, the opinion,of most men believing this, is that it is lost by repeated animal inoculation and also by growth on artificial media.

Not all hemolytic streptococci are pathogenic for animals. Perhaps the most pathogenic, at least those occurring most frequently in pathological lesions, are: Streptococcus pyogenes, streptococcus anginosus, and streptococcus infrequens (9). The virulence of a strain may be greatly enhanced by the inoculation of certain animals, -mice for example.

Although considerable work on immunity, resistance and specific antibodies has been done, many problems still remain obscure. Certain animals, as guinea-pigs, rats and birds, are known experimentally to show more or less natural immunity to streptococci; again, others, like man, rabbit and some of the domestic animals (cows and horses) are more or less susceptible to both natural and experimental infection. Davis (10) says that acquired immunity following a natural streptococcus infection, if it occurs at all, is slight and of short duration. As a matter of fact many streptococcal infections seem to predispose to successive attacks. Again, some investigators claim to have produced an immunity against streptococcal infections,

experimentally, (Clark and Felton) (11) (Moore) (12) but even here the immunity never lasted long - seldom over a few weeks. From this, it has been inferred that vaccination against streptococcic infections is of little practical value. Potter (13) from observations made in oral sepsis is of the opinion that autogenous vaccines or vaccines made from streptococcus viridans clear up the local infection, but as stated above, the streptococcus viridans was the bacterium considered, and not the streptococcus hemolyticus. Joetten (14) reports favorable results in active immunization with a polyvalent vaccine prepared from strains of streptococci from severe cases of puerperal fever, and suggests the possibility of reducing the mortality in septicemia due to or resulting from infections of pregnancy.

Many others, however, are of the opinion that injections of killed streptococci have little or no value in producing effective immunity. Weaver (15) concludes that killed streptococci when injected into an animal may raise its resistance to living virulent streptococci. Injections of galactose-killed streptococci early in the course of scarlet fever do not prevent later streptococcic complications, and similar injections in acute erysipelas and in the acute stage of streptococcic complications of contagious diseases appear not to influence the course of the disease.

Likewise, serum preparations in treatment and immunization of streptococcic infections have been of doubtful value. Edwards (16) says that the use of Marmoreck's antistreptococcic serum has given no essential reduction in death rate in treat-

ment of puerperal fever and its suggestive effects in isolated cases are easily misleading. An enormous amount of investigative work has been done on this phase of the streptococcus problem, and a general resume would seem to indicate that some degree of immunity can be obtained under very favorable conditions; but at the present time, at least, it is not sufficient to be of practical value.

About the same degree of uncertainty exists regarding agglutination of streptococci as regards protective immunity.

Virulence of streptococci is a variable property. Two or more strains may be identical in every detail - growth, sugar fermentation, hemolytic power, morphology, H ion concentration - yet one may be practically non-pathogenic for animals and the other so pathogenic that o.ool cc of a twenty-four hour broth culture will kill a mouse in twenty-four to thirty-six hours. As already stated this characteristic is experimentally changeable - i. e. the virulence of a strain may be greatly enhanced by successive animal inoculation and vice-versa. A highly virulent strain may be made practically non-pathogenic by long continued growth on artificial media, by heat, and by long incubation.

Hemolytic streptococci are not very resistant to external factors, as heat (17) and antiseptics, and consequently their distribution is not very general. They are found in the tonsils (18) almost constantly and commonly in the upper respiratory tract. The normal body surface is quite free from this organism, but they may be found on the skins of filthy individuals, especially in the hairy regions (19). They are found in milk,

being responsible at times for sore throat epidemics (20). They are found in dust and also in water, but probably never live long in such media under natural conditions. However, in the laboratory a strain placed in sterile water lived eighty-seven days (21).

Pathologically streptococci are found in many diseases, especially as secondary invaders. Erysipelas is a primary hemolytic streptococcus infection, and septicemia, pneumonia, tonsilitis, arthritis, meningitis and appendicitis are common examples of other primary or secondary streptococcus infection.

Many classifications of streptococci have been advocated; merely a brief summary will be here given. No doubt, Cohn (22) was the first to attempt to classify them. He placed them in the second tribe of "Schizophytis" (Nageli classification) as Nematogens. Zoph (23) considered them as a genus of the coccaceae. Baumgarten (24) in 1890 placed them as a subgenus of the genus "cocci". After this the classifications were differential in character, and Von Lingelsheim (25) was the first to so classify the various strains of streptococci, which was as follows:

Streptococci

1. Non-pathogenic
   - streptococcus brevis
2. Pathogenic
   - a. for mice and rabbits
     - 1. streptococcus pyogenes
     - 2. streptococcus muriseptins
   - b. for rabbits only
     - 1. streptococcus erysipelas

As seen from this chart the early workers correlated pathogenicity with length of the chains formed, i. e. the longer the chain, the more pathogenic. A more modern classification was that of Schottmüller (26) in 1903, who divided all streptococci into three groups:

1. Streptococcus viridans
2. Streptococcus hemolyticus
3. Streptococcus mucosus

This classification was based chiefly on the reactions and appearance on blood-agar media. In 1916 Holman (27) published a classification based upon both hemolysis and the various sugar reactions. This classification is a satisfactory means of differentiation, is easily applied, and gives quite consistant results. It is extensively used. Holman has given the following:

SEE TABLE 1.

CLASSIFICATION AND ETIOLOGY OF APPENDICITIS

A brief review of the etiology of appendicitis will be presented in order to give a more accurate conception of the relation of hemolytic streptococci to this lesion. Appendicitis has been variously classified; a comprehensive classification is that of McCarty who gives the following types:

(a) Appendicitis catarrhalis acuta
(b) Appendicitis catarrhalis chronica
(c) Appendicitis purulenta necrotica
(d) Peri-appendicitis acuta
(e) Obliteration

The above classification is the result of the examination of 5000 appendices at the Mayo Clinic. The essential factor is an infection and results whenever bacteria are present and the resistance has been sufficiently lowered either by mechanical or metabolic injury; for this reason it often follows or is associated with acute febrile diseases. The young are most frequently affected and those below twenty years are the usual ones likely to have appendicitis. Symptoms are often enhanced and at times primarily caused by indiscretion in diet and by constipation. Chase (28) concludes that appendicitis is extremely rare in countries where the diet is strictly vegetarian and the importance of hematogenous infection as a source of appendicitis should be emphasized; on the other hand, Shattock believes that vegetarianism may be the cause of appendicitis. Rheindorf (29) claims to have found the oxyuris vermicularis in 6 out of 13 cases of appendicitis in children. More recently he has enforced the claim that this parasite very often causes appendicitis (30). Aschoff and also Susuki (31) insist that this parasite rarely if ever is an etiological factor. Pin worms are rarely found, and then in children.

Since appendicitis appears to be essentially an infection, and since bacteria are present in this lesion practically constantly, bacteriological studies would seem to be of chief significance in a consideration of the etiology of appendicitis. However, a specific causative organism is actually not known. Osler (32) says "the bacillus coli is present in a large number of cases and the pyogenic organisms, particularly the streptococcus pyogenes". Rose and Carless (33) mention similar

organisms as the cause of appendicitis. There is an enormous amount of literature on its etiology and the variety of opinion is equally as great. Since the results are so inconclusive it does not seem worth while here to elaborate further upon this subject.

TECHNIQUE

In all, one-hundred and seventy-five appendices were examined; of these, the first fifty were used in a preliminary piece of work, in order to develop technique. The appendices were gathered from various clinics (34). Immediately after removal and while they were still free from external contamination, they were placed in sterile cheese cloth several layers thick and the whole wrapper in clean waxed paper. They were then placed in an ice-box until I could personally collect them. No appendices were used that were more than 24 - 36 hours in the ice-box, even though collected as described above. They were removed from the hospitals to the research laboratory in large sterile glass tubes. The tubes were used for two reasons; - first, the ease of keeping the appendices in their original condition, - second, a convenient method of transportation. Gross examination, smears of lumen contents and mucosa, and bacterial cultures of the mucosa and wall were made at once. The appendices were examined on a sterile porcelain plate. All instruments, knives, probes, scissors, platinum loops, etc. used in disecting the material were thoroughly sterilized before being applied. The examination of each appendix was performed with rapidity, yet with precision in order to reduce external contamination and internal change to a minimum. Cultures of

the mucosa and wall were made by scraping and macerating the mucosa and muscular layers with a sterile knife, and using some of the finely divided tissue for broth and poured blood-agar plates. The plates and broth cultures were incubated for 24 hours at 37°C and the colonies and growth in broth were then examined by methylene blue and Gram's stains for bacterial characteristics. The blood-agar plates were examined for colony growth with special reference to hemolysis, size, shape, color, elevation, pigmentation, moisture, predominence, and variety of colonies. Only those colonies that gave a distinct hemolysis about a small pin-point greyish, slightly elevated growth, and that on staining showed Gram positive cocci growing in chains or diplococci form were tabulated as hemolytic streptococci. Although, the above tests are practically conclusive, later confirmatory tests were made and the organisms grouped in accordance with Holman's (35) scheme. All non-hemolytic streptococci producing a green halo were classed tentatively as streptococcus viridans without further attempt at classification. After cultures and smear preparations were made, the specimens were again placed in an ice-box so as to be available for re-examination should uncertain results appear.

RESULTS

The results are presented in tables 11 and 111. In my series of appendices, 48 were normal and 77 were pathological. The criteria for this differentiation will be discussed later. Two strains of hemolytic streptococci were isolated from the forty-eight apparently normal appendices; these were strains 18 and 54 and belong to the type "streptococcus infrequens".

Four strains of hemolytic streptococci were found in the seventy-seven pathological appendices. These were strains 37, 39, 71 and 104, all of which belonged to the type "streptococcus infrequens", except strain 104 which belonged to the type "Streptocccus hemolyticus 11" (See tables 11 and 111). From this it appears that hemolytic streptococci occurred in this series in normal appendices in 4.17 percent and in the pathological in 5.2 percent. No hemolytic streptococci were isolated from twenty five appendices presenting evidence of chronic inflammation. The acute appendices, from which hemolytic streptococci were isolated, were either ulcerative or gangrenous.

Other findings were as follows: One hundred and eight strains of non-hemolytic colon bacillus, of which forty-five strains were found in forty-eight normal appendices and sixty-three strains in seventy-seven pathological appendices; fifty-one strains of colon bacillus with hemolysis, of which nineteen were found in forty-eight normal appendices and thirty-two in seventy-seven pathological appendices. Twenty-two strains of streptococcus viridans were isolated from forty-eight normal appendices and twenty-nine strains from seventy-seven pathological appendices. Less frequent findings were two probable strains of pneumococcus, one case of pin-worm and many large unidentified bacilli, which were, no doubt, non-pathogenic (See tables 111 and IV).

In normal appendices, hemolytic streptococci when found occurred only in few numbers. One loopful of the macerated mucosa and wall when added to blood-agar, plated and incubated for twenty four hours gave six to ten colonies. Streptococci in chains of four to twelve, were found in smears from the walls

and lumen content, but these, no doubt, were practically all viridans as the blood-agar plates verified. Leucocytes were seen only occasionally in the normal appendices. Hemolytic streptococci when isolated from pathological appendices were present in large numbers; furthermore, they were in practically pure culture. One loopful of the lumen content or macerated walls of the appendices when placed in 5 cc of blood-agar, plated and incubated for twenty four hours caused complete hemolysis and the colonies were innumerable. The third dilution was usually necessary for the isolation of individual colonies, and even such plates contained twenty to forty colonies. Smears from the lumen and walls showed an almost pure culture of streptococci, which were Gram positive and in chains of four to sixteen. One case was practically a pure culture of diplococci, which on growth in beef broth developed chains of six to eighteen. The smears, furthermore, showed an enormous amount of polymorphonuclear leucocytic infiltration; many pus cells and cells with injested bacteria were present. Blood cells were present too, but most of these were already disentegrated.

The morphology and cultural characteristics of the streptococci isolated were typical. The strains were classified in accordance to Holman's scheme (See tables 1 and 11). Five of the strains were of the "Streptococcus infrequens" type, and one strain was of the "Streptococcus hemolyticus 11" type. Strains 18, 37, 39, 54 and 71 fermented lactose, mannit and salicin, while number 104 didnot ferment lactose but did ferment mannit and salicin. Strain "A" was used merely as a check; it had been previously isolated from a case of acute tonsilitis.

The hemolytic streptococci isolated in this series proved to be pathogenic for rabbits. The strains were incubated in 5 cc of plain beef broth at 37°C for eighteen to twenty-four hours; 3 cc of these cultures were injected intravenously into the lateral vein of the ear of young healthy rabbits weighing 1000 to 1200 grams. Two rabbits were similarly injected with sterile beef broth for controls. Strains number 37, 39, 71 and 104 killed the rabbits in forty eight to seventy two hours. I was able to observe one of them as it was dying. The respirations were rapid and shallow at first, but later they became slow and labored; the animal was dyspnoeic, the ears injected and hyperemic, the tongue and lips were cyanotic. The temperature was moderately high to the end. The organisms were recovered in pure culture from the heart-blood. Ten drops of the blood when plated presented twenty to thirty colonies. Strains 18 and 54 killed rabbits in five days, when the cultures were similarly injected. The organism was recovered from the greyish pus of the joints. No other gross lesions were noted.

The direct etiology of the four acute cases of appendicitis of this series is, no doubt, attributable to the hemolytic streptococci. There appeared to be no important predisposing factors. Following is a history of one of the acute cases, which may be taken as representative of the series:

> Miss G. W. entered Augustana Hospital 8/7/19 under the care of Dr. A. J. Ochsner, age 20, occupation Milliner,
>
> History - Pain in right lower quadrant started yesterday AM (8-6-19), was very intense, and became

worse after an hour. The pain was accompanied by vomiting. Very little temperature was present at this time. There was general prostration; no other prominent symptoms.

Past History - Negative

Physical examination - Head, scalp, ears, mouth, nose, neck were all negative. Chest heart and lungs were normal.

Abdomen - there was extreme rigidity of both recti-muscles, but more so on the right side. Pressure over McBurney's point caused extreme pain.

Clinical diagnosis - Emergency appendicitis

Operation - Appendectomy

Surgical pathology:

Appendix was very large and inflamed and appeared as if it were gangrenous in places. A stone was found at entrance of the appendix. Inspection of the opened appendix revealed an almost complete gangrenous specimen; there seemed to be two foci-one near tip and another 1 Cm from opening. The lumen also contained fine granular material and also bloody fluid.

Very likely, the stone present operated as a predisposing cause by irritating the mucosa and causing lowered local resistance, which gave the hemolytic streptococcus an opportunity to do damage. The history revealed no previous illness or recent infection (such as tonsilitis) and no other focus of infection

was found on examination.

DISCUSSION

As stated above, of the one hundred and twenty-five appendices of which a record was kept, seventy-seven were pathological and forty-eight were normal. This classification was made on the basis of gross pathology and clinical diagnosis. By gross pathology I mean any abnormality which is perceptible without the aid of the microscope, for example, abscess, rupture, adhesions, obliterations, swelling, hyperemia, obstructions, hemorrhage, abrasions of mucosa. By clinical diagnosis, I mean, only those cases of appendicitis that give a history of pain with sudden onset, at first diffuse in the abdomen and localizing in ten to twelve hours over McBurney's point; nausea and vomiting, the vomiting occurring usually once, rarely twice and practically never thrice; leucocytosis and high temperature 102 to 104 C. It is to be emphasized that at times, it becomes extremely difficult to determine whether an appendix is normal or slightly pathological. The statement has often been made by pathologists and surgeons that in adults an absolutely normal appendix does not exist. No doubt there is much truth in this statement. Since appendicitis rarely occurs before the age of five, one should find normal appendices at this stage of life, and especially immediately after birth before a bacterial flora or toxic products may have reached the organ. The statement emphasizes the fact that the organisms harbored there are ever ready to do mischief should predisposing factors be favorable.

A word should be said in regard to the possible avenues by which hemolytic streptococci reach the appendix. As elsewhere, three routes are usually considered, which are: by contiguity,

by progression and by hematogenous or lymphogenous routes. There was no peri-appendiceal involvment in any case in which the hemolytic streptococcus was found, and for that reason, one may, with reasonable certainty, say that the mode of entrance was either by progression along the gastro-intestinal tract or hematogenous. Rosenow(36) and others (37) have laid much stress on the hematogenous route, and name as the primary source the tonsils in a majority of the cases. Rosenow(38) has experimentally produced appendicitis by intravenous injection of the streptococci; he also did the same with injection of colon bacilli. A number of investigators in this connection have emphasized the selective action of certain bacteria for the appendix. As mentioned earlier in this paper this point is still under debate.

Hemolytic streptococci, as a rule, do not frequent the gastro-intestinal tract. They are frequently found in the mouth about the teeth, in the nares, nasopharynx, and upper respiratory tract; also in the crypts of faucil tonsils in practically one-hundred percent(39). With each swallow of food or saliva, countless numbers of these bacteria must pass down the oesophagus to the stomach. Here most of the hemolytic streptococci encounter their fate. The media of the stomach is not favorable for their growth, since the ferments and acid of the stomach show a decided antagonistic action toward them. Davis(40) who investigated the viability of hemolytic streptococci in the stomach and in dilute hydrochloric acid says, "Hemolytic streptococci are very sensative to the acids of the stomach and to free hydrochloric acid. When placed, even in large numbers,

in the stomach contents of human beings or rabbits they are all dead in from two to five minutes. Strains vary somewhat, but generally they are killed in two hundred and fifty-sixth normal (0.012 percent) hydrochloric acid in two minutes". Should they enter the intestinal tract in a lump or mass of food, or because of some pathological condition in the stomach in which no acid is secreted, a more favorable media is afforded, although not the optimum. Davis (41) examined fifty-three stools of patients known to harbor the hemolytic streptococci in their throats, but did not find them; he fed the hemolytic streptococci to rabbits every day for a month and only occasionally recovered them in the stools. Holman (42) isolated four strains from feces. Broadhurst (43) isolated nine from thirty-one stools and Oppenheim (44) isolated five strains from fifteen stools.

In 1890 Kruse and Pasquale (45) found streptococci in large numbers in feces of patients with acute dysentary. They were probably non-hemolytic and no doubt that variety known now as streptococcus fecalis. Accurate classification at that time was not possible. Beck (46) in 1892 isolated a streptococcus from cholera nostra stools and concluded that this organism was the causative agent. He does not state whether the organism isolated by him was hemolytic or non-hemolytic. Lameris and Harrevelt (47) obtained streptococci from stools of patients suffering from diarrhea following the use of contaminated milk, but they were not pathogenic for animals. There are many others - Baermann and Ackersdorff (48), Ungermann (49), Rosenow and Dunlap (50), Houston (51), Winslow and Palmer (52), Armstrong (53)-that have isolated streptococci from feces or intestinal content. In most

cases apparently the non-hemolytic streptococcus was the organism under observation. Rosenow and Dunlap (54) reported a streptococcus appendicitis epidemic at Camp Culver and attributed the source to milk infection. According to this report the cause was a hemolytic streptococcus.

Takaki (55), a Japanese surgeon and pathologist of note, reports the occurrence of a hemolytic streptocoocus in five out of fifty cases of acute appendicitis, in every case associated with some other organism, usually with the B. coli communis. He records the streptococcus in each of the five cases as streptococcus pyogenes. He didnot say what method of classification was used. Some others have reported the occurrence of appendicitis due to streptococci, but after reading their reports, it is not clear whether or not the organisms were hemolytic or non-hemolytic.

The isolation of nine strains of streptococcus infrequens from thirty-one stools by Broadhurst is of some interest here because five out of the six strains isolated by me from normal and pathological appendices were of the same type.

SUMMARY AND CONCLUSIONS

1 Hemolytic streptococci were found in two of forty-eight normal appendices; approximately in 4.17 percent.

2 Hemolytic streptococci were found in four of seventy-seven pathological appendices; approximately in 5.2 percent.

3 In the pathological series they were found in the acute cases only. They were not

recovered from the chronically inflammed appendices.

4 When hemolytic streptococci occurred in pathological appendices they were present in practically pure culture; while when found in the normal appendices they were present in only few numbers.

5 Two types of these organisms appeared; according to Holman's scheme they were:

Streptococcus infrequens (5 strains) and

Streptococcus hemolyticus 11 (1 strain)

6 Hemolytic streptococci apparently do not play an important role in the production of appendicitis; however, when they do occur in pathological appendices, they usually predominate and appear to be the direct etiological agent.

TABLE 1*

Streptococci

Gram positive cocci in chains, -- no capsules.

Hemolytic	Lactose	Mannit	Salicin	Non-hemolytic
S.Infrequens	+	+	+	S.Fecalis
S.Hemolyticus 1	+	+	-	S.Non-hemolyticus 1
S.Pyogenes	+	-	+	S.Mitis
S.Anginosus	+	-	-	S.Salivarius
S.Hemolyticus 11	-	+	+	S.Non-hemolyticus 11
S.Hemolyticus 111	-	+	-	S.Non-hemolyticus 111
S.Equi	-	-	+	S.Equinus
S.Subacidus	-	-	-	S.Ignavus

* Modification of Holman's original table.

TABLE 11

Classification of strains isolated.*

Strain No.	Lactose	Mannit	Salicin	Type of strain
18.	+	+	+	Streptococcus Infrequens
37.	+	+	+	" "
39.	+	+	+	" "
54.	+	+	+	" "
71.	+	+	+	" "
104.	-	+	+	" Hemolyticus 11 .
.				
.				
.				
A	+	+	+	Streptococcus Infrequens

*According to Holman's scheme.

TABLE 111

Summary of Results

Normal Appendices.

Number	A*	B*	C*	D*	E*
1	-	+	+	-	Staphlococcus Albus
7	-	-	+	-	-
9	-	+	+	-	-
13	-	+	+	-	-
15	-	-	-	+	concretions
16	-	+	+	-	-
18	+	-	+	+	-
20	-	+	+	-	Staphlococcus Albus
21	-	-	+	-	-
22	-	+	+	+	large unidentified bacilli
23	-	+	+	+	-
25	-	-	-	+	large unidentified bacilli
27	-	?	+	-	pneumococcus?
28	-	-	-	+	-
30	-	+	+	+	-
32	-	-	+	-	-
33	-	-	+	-	-
36	-	-	+	-	a post mortem case
38	-	-	+	+	large unidentified bacilli
40	-	-	+	+	-
41	-	+	+	+	large unidentified bacilli
44	-	-	+	-	concretions
46	-	+	+	-	large unidentified bacilli
47	-	-	+	+	large unidentified bacilli
48	-	-	+	+	-

Number	A*	B*	C*	D*	E*
54	+	+	+	+	-
55	-	-	+	+	-
57	-	+	+	+	-
59	-	+	+	-	-
64	-	+	+	+	-
76	-	+	+	-	large unidentified bacilli
77	-	+	+	+	-
78	-	-	+	+	-
79	-	-	+	-	-
87	-	+	+	-	-
90	-	+	+	-	-
91	-	-	+	-	-
101	-	-	+	-	small -- 2 cm. by 3 mm.
103	-	-	+	-	concretions
107	-	-	+	-	-
110	-	+	+	-	-
113	-	+	+	-	-
118	-	-	+	-	concretions
119	-	+	+	-	-
120	-	few	+	-	-
121	-	-	+	-	-
122	-	-	+	+	-
124	-	-	+	-	-
			ACUTE APPENDICES		
2	-	+	-	-	-
3	-	+	+	+	-
5	-	-	+	-	-

Number	A*	B*	C*	D*	E*
6	-	-	+	-	-
8	-	+	+	-	concretions
10	-	+	+	-	-
11	-	+	+	-	-
12	-	+	-	+	-
14	-	+	+	-	-
19	-	-	+	-	-
24	-	?	+	+	pneumococcus ?
26	-	-	+	-	concretions
31	-	+	+	-	concretions
34	-	-	+	+	large unidentified bacilli
37	+	-	+	-	-
39	+	-	+	+	-
42	-	-	+	+	concretions
43	-	+	+	-	concretions
45	-	-	+	+	large unidentified bacilli
49	-	-	+	+	concretions
51	-	-	+	+	concretions
56	-	-	+	-	large unidentified bacilli
58	-	+	+	-	concretions
60	-	-	+	+	concretions
62	-	-	+	+	concretions
63	-	-	+	+	-
65	-	+	+	+	large unidentified bacilli
66	-	-	+	+	-
67	-	-	+	-	large unidentified bacilli
68	-	-	+	+	-
69	-	-	+	-	concretions

Number	A*	B*	C*	D*	E*
70	-	-	+	+	large unidentified bacilli
71	+	+	+	-	granulations
72	-	-	+	-	-
73	-	-	+	+	concretions
74	-	-	+	-	-
80	-	-	+	-	concretions
84	-	+	-	+	ruptured
88	-	+	+	+	-
93	-	-	+	+	large unidentified bacilli
95	-	+	+	few	-
97	-	+	+	-	-
99	-	-	+	-	concretions
100	-	+	+	+	large unidentified bacilli
102	-	+	+	-	-
104	+	-	few	few	-
109	-	+	+	-	-
111	-	-	+	+	-
114	-	+	+	+	-
115	-	-	few	+	-
123	-	+	+	+	concretions
125	-	+	+	-	acute kink

CHRONIC APPENDICES

4	-	+	-	+	large unidentified bacilli
17	-	+	+	+	-
29	-	+	+	-	-
35	-	+	+	+	large unidentified bacilli
50	-	-	-	-	obliterated

Number	A*	B*	C*	D*	E*
52	-	-	-	-	obliterated
53	-	-	-	-	obliterated
61	-	-	+	+	partially obliterated
75	-	-	-	-	obliterated
81	-	+	-	-	partially obliterated
82	-	+	+	-	large unidentified bacilli
83	-	-	+	-	-
85	-	-	-	-	obliterated
86	-	-	-	-	obliterated
89	-	-	+	?	constricted
92	-	+	+	-	subacute
94	-	-	+	-	-
96	-	-	-	-	obliterated
98	-	-	+	+	-
105	-	+	+	-	partially obliterated
106	-	-	+	-	-
108	-	-	-	-	obliterated
112	-	-	+	-	-
116	-	+	+	-	-
117	-	-	-	-	obliterated

* A Hemolytic Streptococci

B Streptococcus Viridans

C Non-hemolytic Colon bacillus

D Hemolytic Colon bacillus

E Other findings

TABLE IV

Summary of Results

	Normal	Pathological	Total
Hemolytic Streptococci	2	4	6
Non-hemolytic Colon bacillus	45	63	108
Hemolytic Colon bacillus	19	32	51
Streptococcus Viridans*	22	29	51
Concretions	4	16	20
Obliterations	0	12	12
Staphlococcus Albus	2	0	2
Pin worm	1	0	1
Large unidentified bacillus	7	11	18

* This included all non-hemolytic streptococci producing a green halo on blood-agar plates.

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